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By ECFS

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

**Re: Written *ex parte* presentation in IB Docket Nos. 11-109 and 12-340;
IBFS File Nos. SES-MOD-20151231-00981, SAT-MOD-20151231-
00090, and SAT-MOD-20151231-00091**

Dear Ms. Dortch:

Enclosed is a document entitled, "Summary of GPS Reacquisition Testing by Roberson and Associates," which summarizes Roberson and Associates ("RAA") testing with respect to the length of time various GPS devices take to reacquire GPS signals in the presence of adjacent band LTE signals at various power levels.

Please direct any questions to the undersigned.

Sincerely,

/s/Gerard J. Waldron
Gerard J. Waldron
Counsel to Ligado Networks LLC

Enclosure

SUMMARY OF GPS REACQUISITION TESTING BY ROBERSON AND ASSOCIATES

Overview

Roberson and Associates (RAA) conducted testing that measures the amount of time it takes for various GPS devices to reacquire GPS signals in the presence of adjacent band LTE signals. RAA tested and measured reacquisition using a “warm start”: Each device first acquired GPS signals; RAA then removed the GPS signals for approximately one minute; and RAA compared the reacquisition time *with* the presence of LTE signals against the reacquisition time *without* LTE signals.

Test Procedure

We conducted the testing in an anechoic chamber.¹ First, we set up the device under test using Open Sky GPS conditions,² without any LTE signal in the chamber. We then allowed the test device to acquire lock on the GPS signal and waited 20 minutes. Next, we disconnected the GPS signal feed into the chamber and waited approximately 60 seconds for the device under test to lose GPS lock.³ We then reconnected the GPS signal feed and measured the time required for the test device to reacquire the GPS signal lock. We waited 60 seconds after the last lock before disconnecting again. We repeated the disconnecting and reconnecting GPS signal sequence until we took 50 time measurements.

Next, we enabled the LTE signal and repeated this process of allowing the test device to acquire the GPS signal, disconnecting the GPS signal feed, and reconnecting the GPS signal feed to measure the time required to reacquire the GPS signal for the LTE signal conditions and bands listed below. We repeated the disconnecting and reconnecting GPS process until we took 50 measurements for each device in each condition.

Each device/antenna combination was tested under six conditions:

- GPS signal only (no LTE signal)
- -37 dBm LTE at 1526-1536 MHz
- -20 dBm LTE at 1526-1536 MHz
- -10 dBm LTE at 1526-1536 MHz
- -20 dBm LTE at 1627.5-1637.5 MHz
- -10 dBm LTE at 1627.5-1637.5 MHz

¹ ETS-Lindgren AMS 8500.

² For the NavCom SF-3050, we used Live Sky conditions because otherwise the device did not reliably lock onto signals from the GPS simulator. The Open Sky and Live Sky conditions are described in Appendix A of the *Final Report: GPS and Adjacent Band Co-Existence Study* we filed with the FCC on June 10, 2016, available at <https://ecfsapi.fcc.gov/file/60002112685.pdf>.

³ We always waited at least 60 seconds but not more than 70 seconds.

The GPS and LTE test signals were applied in the same manner that they were applied during the RAA GPS compatibility testing program. The GPS signal was generated using a Spirent GPS simulator and supplied to the DUT through a RHCP antenna. The LTE signal was generated using a Rohde and Schwartz SMBV100A and supplied to the DUT through a linear polarized horn antenna.

Test Results

For each condition and device, we examined the 90th percentile result of the 50 time measurements (*i.e.*, the length of time in which 90 percent of the test runs for each condition reacquired the GPS signal).⁴ The table on the following page displays the results of the testing. Each cell indicates the length of time, in seconds, that elapsed before the device reacquired the GPS signal in each condition.

Conclusions

The test results show that reacquisition time for all but one⁵ of the devices showed no significant change when experiencing -37 dBm of LTE in the 1526-1536 MHz band or -20 dBm of LTE in the 1627.5-1637.5 MHz band. Specifically, devices tested under these two conditions reacquired the GPS signal within one second of the reacquisition time in the absence of the LTE signal. When experiencing the higher power of -20 dBm of LTE in the 1526-1536 MHz band, all but two of the devices show no significant change in reacquisition time.

⁴ The 90th percentile figure was calculated using MSFT EXCEL “percentile(array,0.9)” function.

⁵ While experiencing -37 dBm of LTE in the 1526-1536 MHz band, the NavCom SF-3050 with the ant-3001r antenna was unable to reacquire the GPS signal. When tested with the filtered antenna, the NavCom SF-3050 was able to reacquire the GPS signal under all of the test conditions.

90th Percentile Reacquisition Time (in Seconds)

Device	Type	Antenna	Test Condition					
			GPS Only	1526 - 1536 MHz LTE			1627.5 - 1637.5 MHz LTE	
				-37 dBm	-20 dBm	-10 dBm	-20 dBm	-10 dBm
			90th pct.	90th pct.	90th pct.	90th pct.	90th pct.	90th pct.
Furuno GP32	GLN	Furuno GPA-017	3.0	3.0	4.0	3.0	4.0	4.0
Garmin eTrex H	GLN	Internal	8.2 / 6.1 ⁶	6.2	10.0	12.0	7.0	15.0
Garmin GPSMAP 76CSx	GLN	Internal	4.0	5.0	4.0	4.0	4.0	4.0
Garmin GPSMAP 78sc	GLN	Internal	6.0	5.0	6.0	5.0	7.0	5.0
Garmin Montana 650t	GLN	Internal	5.0	6.0	5.1	5.0	6.0	5.1
Motorola APX 7000	GLN	Internal	5.1	5.0	5.0	7.0	5.0	6.0
Motorola MW810	GLN	Motorola 8508851K66	2.0	3.0	2.1	2.0	3.0	3.0
Trimble TM3000	GLN	Gilsson	2.0	2.0	3.0	2.0	3.0	3.0
NavCom SF-3050	HP	ant-3001r	29.1	NA	38.3*	93.1**		
NavCom SF-3050	HP	Filtered Antenna	33.1	28.1	31.2	38.1	29.0	45.2
Topcon HiPer V	HP	Internal	13	13	12	NA	12	NA
Topcon System 310	HP	PG S3	16	17	16.1	17	16.1	17
Trimble AgGPS 542	HP	Filtered Antenna	3.0	4.0	3.0	4.0	4.0	4.0
Trimble Geo 7x	HP	Internal	4.1	4.0	4.0	65.0	4.0	4.0 ***
Trimble R8s	HP	Internal	3.1	3	4.0	4.0	3.1	25.6 ⁷ ,***
Trimble R9	HP	Filtered Antenna	4	4	4.0	4.0	4	4
Trimble SPS855	HP	Filtered Antenna	< 4.0 secs	4.0	3.0	4.0	4.0	4.0
Trimble SPS985	HP	Internal	3.0	3.0	4.0	3.1	4.0	4.0 ****

* -55 dBm

** -45 dBm

*** - 15 dBm

**** -18 dBm

⁶ The 8.2 second measurement corresponds to LTE signal levels of -20 and -10 dBm. The 6.1 second measurement corresponds to -37 dBm LTE level, because that test was conducted separately at a later date.

⁷ When presented with -10 dBm LTE at 1627.5-1637.5 MHz, the Trimble R8s lost lock in 10 out of the 50 trials, and therefore was retested at -15 dBm.